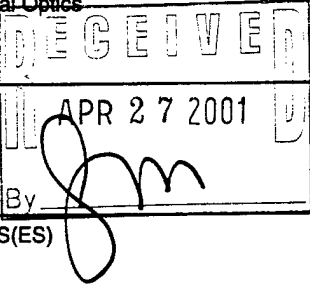


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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) University of Rochester ORPA Hylan 518, Wilson Blvd. Rochester, NY 14627		8. PERFORMING ORGANIZATION REPORT NUMBER 1		
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13. ABSTRACT (Maximum 200 words) A Starrett® PREMIS HGDC 2018-16 direct computer controlled (DCC) coordinate measuring machine (CMM) was purchased and installed in the metrology lab of the Center for Optics Manufacturing (COM) at the University of Rochester. This CMM was a valuable addition to our facility; it allowed for the precise measurement of ground surfaces on a variety of parts generated on the Moore Precision Tools Nanotech® 150AG Aspheric Grinder and the Nanotechnology Systems Nanotech® 500FG Freeform Generator. The unique and complex nature of these parts prevented them from being characterized with standard optical metrology instrumentation. The acquisition of this CMM has opened up new opportunities for collaborations with Army programs.				
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ARO Research

Grant Number:

DAAD 19-00-1-0060

Title:

Coordinate Measuring Machine for Characterizing Conformal Optics

P. I.:

Stephen D. Jacobs

1) ITEMS OF EQUIPMENT ACTUALLY ACQUIRED

We purchased a Hollow Granite Ceramic (HGDC), Direct Computer Controlled (DCC) Coordinate Measuring Machine (CMM), with all necessary accessories for form testing off-axis aspheric and conformal surfaces.

Source:	The L. S. Starrett Company 1000 Cobb Place Boulevard Building 100, Suite 100 Kennesaw, GA 30144	Atten.: Scott Mitchell Regional CMM Sales Manager Tel: 770-590-7737 Fax: 770-590-7511 or Tel: 1-800-784-2887, voice mail box #572
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The items proposed were exactly the items purchased.

Item	Qty	Part #	Description	Unit Price	Total Price
1	1	PREMIS HGDC2018-16	Coordinate Measuring Machine (CMM) w/ <i>Apogee</i> ™ Level IV -direct computer control (DCC) Standard Computational Package	\$54,435.00	\$54,435.00
2	1	C-2150	Renishaw PH9 Motorized Probe Head Kit w/ PHC9 Probe Head Controller, PSU9 Power Supply Unit, and PHD9 Probe Head Drive Unit	\$21,531.00	\$21,531.00
3	1	78929	TP20 Probe Kit	\$3,600.00	\$3,600.00
4	1	CA-1216	Stylus Kit 201	\$630.00	\$630.00
5	1		One year Software Maintenance Contract	\$3,155.00	\$3,155.00
Total Instrument Cost:					\$83,351.00
Cost Sharing Contribution from Starrett:					none†
Total Amount Awarded '00 DURIP:					\$83,351.00
Total Amount Spent '00 DURIP:					\$83,351.00

†Starrett does not offer educational discounts. However, after an evaluation of competing equipment from other U. S. vendors (e.g., Brown & Sharpe) who do offer up to 15% in educational discounts, we found that the Starrett CMM was the least costly and best system for our requirements.

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2) CONCISE SUMMARY OF RESEARCH PROJECTS

A Starrett® PREMIS HGDC 2018-16 direct computer controlled (DCC) coordinate measuring machine (CMM) was purchased and installed in the metrology lab of the Center for Optics Manufacturing (COM) at the University of Rochester. This CMM was a valuable addition to our facility, because it allowed for the precise measurement of ground surfaces on a variety of parts generated on the Moore Precision Tools Nanotech® 150AG Aspheric Grinder and the Nanotechnology Systems Nanotech® 500FG Freeform Generator. Its acquisition has opened up new opportunities for collaborations with Army programs.

Specific examples of the use of the CMM were as follows:

a) Metrology Instrument Calibrations

Several known spherical surfaces were measured on the CMM to calibrate it against other instruments in COM. These included the Zygo GPI xp phase measuring interferometer (purchased under a DURIP from 1997-98) and an older Taylor Hobson Series 1 Form Talysurf-120L (FTS S5) stylus profiler. It was determined that the instrument accuracy could be improved from 2.5 μm (full envelope) to ~0.5 μm (small envelope) for parts ~70 mm in diameter. This was important for it gave us the capability for 3-dimensional metrology of ground surfaces over a range of part sizes.

b) Off-Axis Spherical Part

A rotationally symmetric off-axis spherical part, made on the Nanotech™ 150AG Ultra-Precision Aspheric Grinder from SF56 glass, was evaluated for a project with Picatinny Arsenal. The part was 146 mm in diameter, and it had a sag of 35 mm. The CMM was the only instrument in our facility that could measure such a part.

c) MgF_2 Dome

A small diameter missile dome, manufactured on the Nanotechnology Systems Nanotech® 500FG Freeform Generator, was characterized on the CMM. The dome was 63 mm wide at the bottom and 62 mm high. The interior surface shape was an ellipse, and the outer surface shape was defined by a set of cubic splines to approximate an ellipse. The part was generated, tested, and sent to a military contractor for final finishing. This MgF_2 dome has applications in the Army Man-Portable Missile Systems Program.

d) Visor Mold

Fused silica blocks 127 mm by 102 mm by 76 mm thick were pre-ground on the OptiPro SX 150, and then precision raster-ground on the Nanotech® 500FG Freeform Generator into a set of convex and concave mold masters. Since the final ground surfaces were cylindrical along one axis and steep aspheres along the other axis, the only metrology tool capable of assessing form was the CCM. These parts will have an impact on the manufacture of plastic optics for the Army's Land Warrior Soldier System & Soldier Enhancement Program.

Because of our proven capability for precision generating and characterization using the CCM acquired under this DURIP Grant, the following collaborative projects have been established for FY 2001-2002:

- e) Off-Axis Reflective Aspheres for Targetting Systems on the Commanche Helicopter
- f) Missile Nose Cones manufactured from Aluminum Oxynitride Spinel (ALON)
- g) Mold Masters for the Objective Individual Crew Weapons Program (OICW)
- h) Precision Ground Glass Visor Elements for OICW